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Indian Standard

SPECIFICATION FOR ELECTRICAL CABLES FOR AIRCRAFT

PART I GENERAL REQUIREMENTS AND TESTS

UDC 621·315·2 : 629·13·066

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MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 8

December 1982

Indian Standard

SPECIFICATION FOR ELECTRICAL CABLES FOR AIRCRAFT

PART I GENERAL REQUIREMENTS AND TESTS

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Indian Standard

SPECIFICATION FOR ELECTRICAL CABLES FOR AIRCRAFT

PART I GENERAL REQUIREMENTS AND TESTS

0. FOREWORD

0.1 This Indian Standard (Part I) was adopted by the Indian Standards Institution on 28 July 1982, after the draft finalized by the Aircraft Electrical Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard specifies the general requirements, and methods of tests to verify the requirements of electrical cables used for aircraft.

0.3 This standard has been brought out to specify the various requirements that have to be satisfied by the cables to be used in aircraft, and to standardize the type of cables to be used, so that there could be substantial saving in material.

0.4 This standard is being brought out in a number of parts. The requirements of cables for individual applications shall form the other parts of this standard. This standard shall hence be used in conjunction with the other parts which are under preparation.

0.5 In the preparation of this standard, considerable assistance has been derived from ISO/DIS 5097 'Aircraft—Electrical cables—General requirements' issued by the International Organization for Standardization.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS: 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard (Part I)specifies the general requirements and methods of tests for verifying the requirements of various electrical cables used for aircraft.

---

*Rules for rounding off numerical values (*revised*).

1.2 The general requirements are specified in Section **A**, and the methods of tests in Section B.

1.3 The requirements of cables for individual applications are dealt with in the subsequent parts of this standard.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Conductor — Conducting portion of an electric cable.

2.2 Stranded Conductor — Conductor consisting of several wires, all arranged concentrically. The stranding directions, from one layer of strands to the next layer, are either alternating or identical, but of different lengths of lay.

2.3 Unidirectional Lay Conductor — Conductor consisting of several strands, all arranged concentrically in the same direction and the same lay.

2.4 Rope Stranded Conductor — Conductor consisting of a number of stranded conductors or unidirectional lay conductors arranged in concentric layers, alternate layers being twisted in opposite directions.

2.5 Wire — Cylindrical metal wire of uniform cross-section used to form the conductor.

2.6 Insulation (**or Insulating Jacket**) — Part of a cable surrounding the conductor and providing its electrical insulation.

2.7 Core — Assembly of conductor and insulating jacket, excluding any other covering.

2.8 Screen — Plated copper wires, braided over the cores.

2.9 Protective Covering — External covering of a cable protecting the insulating jacket against deterioration due to abrasion or fluids.

2.10 Cable — Assembly consisting of the conductor, the insulating jacket and the protective covering.

SECTION A GENERAL REQUIREMENTS

3. MATERIALS

3.1 Copper and Copper Alloy Conductor and Wires — Copper conductors and wires used for conductors and screens shall be of annealed bright conductivity copper having a resistivity not greater than 1·724 micron cm at 20°C. The conductors shall comply with the tensile test requirements specified in **7.29**. Copper alloy conductors and wires shall, before stranding, satisfy the requirements of the individual cable specifications. Nickel coated conductors or wires shall be coated to the thickness specified in the individual cable specification, and shall comply with the test requirements of **7.30** and **7.32**. Silver plated conductors or wires shall be coated to the thickness stated in the individual cable specification, and shall comply with the requirements of **7.30** and **7.33**. Tinned conductors or wires shall comply with the tinning tests specified in the individual specification.

3.2 Aluminium and Aluminium Alloy Conductors and Wires — Aluminium conductor wires shall before stranding, have a resistivity not greater than 2·873 micron cm at 20°C. Wires taken from the stranded conductor shall comply with **7.30**. Aluminium alloy conductors and wires shall, before stranding, satisfy the requirements of the individual cable specification. The hardness of the conductor wires shall be as specified in the individual cable specification.

NOTE — Certain types of crimped terminations may not be suitable for use on aluminium conductors.

3.3 Insulation — The insulation shall be as specified in the individual cable specification and shall be of such quality that the finished cables comply with all the requirements of this standard and of the individual cable specification. The material used shall be free from ingredients likely to cause staining or discolouration of the cable.

3.4 Glass Braid — The free alkali content of glass braid shall not exceed 1 percent. The glass shall be of such quality that the finished cable complies with all the requirements of this standard and of the individual cable specification.

3.5 Protective Covering — Outer covering materials such as sheath and tape shall be in accordance with the requirements of individual cable specification.

4. CONSTRUCTION

4.1 Conductors — The conductors shall have the number and diameter of wires (unidirectional lay, stranded or rope stranded) as specified in the individual cable specification. There shall be no kinks or other irregularities in the complete conductor.

4.1.1 Joints in single copper wires shall be brazed or hard soldered. There shall not be more than one joint in each 50 m of single wire. The complete conductor shall not be jointed, and joints in single wires shall not be less than 3 m from any other joint.

4.1.2 In aluminium conductors, the ends of individual wires may be tucked into the conductor.

4.2 Complete Cable — The details of construction shall be in accordance with the requirements of individual specification. The insulation and other coverings shall be applied to give a circular cross-section, they shall not be loose on the conductor but it shall be possible to strip them to allow satisfactory termination.

4.3 Colour Fastness — All colours used in the manufacture of the finished cable shall be fast to light and moisture. The materials used shall be capable of retaining their colours after storage for long periods, in the tropics.

4.4 Metal and Glass Braids — The formulae for calculating braiding details shall be as given in Appendix A.

5. CODIFICATION

5.1 Phase Identification — When required by the purchaser, phase identification shall be provided on the cables by means of helical stripes in colours. The width of the stripe shall be as given in Table 1.

TABLE 1 STRIPE WIDTHS

NOMINAL CABLE CROSS SECTION mm^2	STRIPE WIDTH mm
0·15 to 1·0	1·5 ± 0·5
1·20 to 5	3·0 ± 1·0
9 to 107	5·0 ± 1·5

The length of lay for all sizes shall be 10 mm minimum and 40 mm maximum.

5.2 Multicore Cable Identification — When required by the purchaser, the individual cores of multicore cables shall be identified by the use of colours covering the total surface area of the core.

5.3 Cable Identification — The cable shall be identified by its name and size, together with letters to indicate country of origin, manufacturer and year of manufacture as given in Table 2.

5.3.1 The nomenclature shall be applied to the cable in the manner specified in the individual cable specification. It shall be permanent and legibly printed on the cable.

5.3.2 On cable sizes 0·6 to 10·7 mm², the horizontal axis of the characters shall be preferably parallel to the axis of the cable. On sizes smaller than 0·6 mm², the horizontal axis of the characters shall be at right angles to the axis of the cable.

5.3.3 The height of the characters on cable sizes 0·25 to 5 mm² shall be approximately two thirds of the maximum cable diameter, and on cable sizes 9 to 107 mm² it shall be as applied to size 5 mm². All letters shall be in capitals.

5.3.4 *Cable Name* — The cable name shall be that required by the individual specification. Abbreviations of the name shall only be those specified by individual cable specification.

5.3.5 *Cable Size* — The cable size shall correspond with the conductor size identification as stated in the individual cable specification.

5.3.6 *Country of Origin* — The sole letter for the country of origin of the cable shall be as given below:

Example — IND (for INDIA)

5.3.7 *Manufacturer's Code Letters* — The manufacturer shall not mark the cable itself with his name and address, but with code letters in accordance with the manufacturer's identification marks as given in Appendix **B**.

5.3.8 *Year of Manufacture* — This character in the nomenclature shall be a letter to indicate the year of manufacture. All manufacturers shall use the same letter for the current year, which shall be in the year in which the insulators were applied. Some typical identification letters are given in Table 2.

TABLE 2 LETTERS FOR IDENTIFICATION OF THE YEAR OF MANUFACTURE

(*Clauses* 5.3 *and* 5.3.8)

YEAR OF MANUFACTURE	IDENTIFICATION LETTERS
1981	V
1982	W
1983	X
1984	Y
1985	Z

5.3.9 *Designation of the Cable* — For the purpose of references on drawings and orders, the cables shall be designated by the individual cable specification number, together with the individual cable name and size, and if relevant, the phase colour or colours.

6. PACKAGING AND LABELLING

6.1 The cables may be supplied on reels, drums or coils. They shall be wound regularly and uniformly. The two ends of the lengths of the cable shall be easily accessible for the application of prescribed tests. After testing, the cable shall have its ends sealed to prevent the ingress of moisture.

6.1.1 Each length shall have a label indicating the name of the manufacturer, composition and cross-section of conductor, month and year of manufacture, release or contract reference numbers, and the length in metres.

6.1.2 The delivery lengths shall be as specified in the individual cable specification or as stated in the contract.

SECTION B METHODS OF TESTS

7. TESTS

7.1 General

7.1.1 Tests shall be made to prove compliance with the relevant requirements of this standard and the individual cable specification. It is neither intended, nor recommended, that all tests be made on all or every cable length supplied.

7.1.2 Cables with a metal screen, made from the basic cable (where permitted by their individual specifications) shall satisfy the requirements of further tests.

7.1.3 The manufacturer shall produce evidence to the satisfaction of the approving authority that cables of the types to be supplied to the individual specifications fulfil the requirements stated therein.

7.1.4 After obtaining type approval, the manufacturer shall also disclose to the purchaser and the approving authority any proposal to introduce construction or processes differing from those used for the cable submitted to type tests, and shall obtain written approval of the approving authority before applying the change to production.

7.1.5 Test for coating of copper wires for the conductor or screen in accordance with **7.31**, **7.32** or **7.33** shall be made on the wires before manufacture of the cable.

7.2 Type and Routine Tests

7.2.1 *Type Tests*

7.2.1.1 Type tests, selected as appropriate from the following tests and as specified in the individual cable specification, shall be made on separate specimens from a sample selected from each group of cable types and sizes stated in the individual cable specifications. A sample shall be regarded as being representative of all cables in its group, provided they are made by the same process and with the same materials within the group from which it is selected. In the group comprising the smaller sizes of cable, the cable tested shall be the smallest size proposed to be manufactured. Any change in the materials utilized for the cables, or any change in manufacturing techniques, shall necessitate re-submission of the cables to the type approval tests.

7.2.2 *Routine Tests*

7.2.2.1 Routine tests, selected as appropriate from the following tests and as required by the individual cable specification, shall be made on every length of cable.

7.3 Current Rating Data

7.3.1 Current rating tests shall be made in accordance with Appendix C on all new designs of cable and each cable manufacturer shall show compliance with the current rating data in the individual cable specification. Once compliance has been established by a manufacturer, it shall not be necessary for that manufacturer to repeat the tests unless there has been an alteration in the dimensions of the cable, in the basic materials, or in the design. A change in process, or in the place of manufacture within a manufacturing organization (which normally entails a repetition of those type tests that the approving authority considers critical) shall not entail a repetition of the current rating tests.

NOTE — If the cables are used to the limit of the maximum frequency declared corrections for skin effect may be necessary.

7.4 Voltage Test

7.4.1 A specimen 15 m long shall be immersed in a solution of 3 percent sodium chloride and 0·2 percent wetting agent in distilled water at room temperature for 1 h, with 150 mm at each end protruding above the surface of the solution. At the end of this and while still immersed, it shall withstand without breakdown, a voltage as stated in the individual cable specification applied at a uniform rate and maintained for 5 min. The regulation of the supply for the voltage test shall be such as to maintain the specified voltage on the cable throughout the test. The peak value of the voltage wave shall be within $\sqrt{2} \pm 5$ percent times the rms value and the frequency shall be at any value from 25 to 100 Hz inclusive. Metal screened cables shall be tested between the conductor and the metal screen without immersion in water.

7.5 Insulation Resistance Test

7.5.1 After the application of the voltage test specified in **7.4.1** and while the specimen is still immersed, the insulation resistance for 1 km, measured between the conductor and the water after electrification for 1 min at an applied voltage of 500 V dc, shall not be less than the specified value when corrected to a temperature of 20°C. The rate of change in apparent insulation resistance during the 1 min electrification shall be steady.

7.6 Voltage at High Temperature

7.6.1 Five turns of cable shall be wound into a metal mandrel, the diameter of which shall be 10 times the maximum specified diameter of the cable for sizes 0·25 to 5 mm^2, and 15 times the diameter of the cable for sizes 9 mm^2 and larger.

7.6.2 The assembly shall be placed in an air oven, the temperature of which shall be slowly raised to the temperature specified in the individual cable specifications. After the specified time at this temperature, a voltage as given in the individual cable specification, and of waveform as specified in **7.4.1** shall be applied between the conductor and the mandrel. Cables with a metal screen shall have the voltage applied between the conductor and the metal screen. The cable shall withstand this voltage without electrical failure for the period of time stated in the individual cable specification.

7.7 Spark Test on Insulated Core

7.7.1 A spark test, in accordance with the individual cable specification, shall be made on all dry insulated cores at the specified voltage. Where required by the individual cable specification, voltage and insulation resistance tests shall also be made on 5 percent of all the cores in accordance with **7.4.1** and **7.5.1**.

7.8 Spark Test and Voltage Test on Completed Cable

7.8.1 A spark test in accordance with the requirements of the individual cable specification shall be made on all completed cables, except metal screened cables. Completely metal screened cable shall, in the dry state, withstand the voltage required by the individual cable specification, applied for 1 min between the conductor and the metal screen.

7.8.2 In addition, on cables with a metal screen and an outer protective covering, a spark test complying with the requirements of the individual cable specification shall be applied between the metal braid and a suitable electrode system on the outside of the cable. An instrument to the satisfaction of the inspecting authority shall be used to detect electrical failure.

7.9 Conductor Resistance

7.9.1 The conductor resistance shall be measured by any convenient method on all completed cables, and the resistance of a single conductor per kilometre of the finished cable shall not exceed the values given in the individual cable specification, when corrected to the specified temperature.

7.10 Resistance to Fluids

7.10.1 Specimens shall be bent into single U-shaped loops, each with an internal diameter as given in the individual cable specification. The specimens shall be immersed one in each of the fluids specified in the individual cable specification. The specimen ends shall be 150 mm above the surface of the fluid, which shall be maintained at the temperature required by the individual cable specification for not less than 20 h.

7.10.2 At the conclusion of this period, each specimen shall be removed from the fluid and the following procedures shall be adopted. Each specimen shall be straightened wiped clean and allowed to return to room temperature. Within 1 h after straightening, the specimen shall be bent through 360° around a mandrel of diameter as specified in the individual cable specification and in the same direction as the original bend. The specimen shall be retained on the mandrel for 1 min unwound and then subjected to a voltage test (*see* **7.4.1**).

7.10.3 On completion of the test, neither cracking, softening of the insulation, nor other deterioration shall be observed. Cable identification shall remain legible. Core identification shall remain effective. In the case of both the identification legend and the core colours, a change in colour which does not affect legibility of effectiveness shall be disregarded. The change in overall diameter shall not exceed the values given in the individual cable specification.

7.11 Ageing in Air

7.11.1 A suitable length of cable having the insulation removed for 25 mm at each end, shall be bent at least half way round a cylindrical mandrel of diameter as given in the individual cable specification. The conductor shall be loaded in such a manner that the portion of the insulation between the conductor and the mandrel is under compression when the conductor has the mass required by the individual cable specification attached at each end. These conditions shall be maintained for the specified period in an air even at the constant temperature specified in the individual cable specification. On removal from the air oven, the specimen shall be cooled within the time and to the temperature stated in the individual cable specification. There shall be no signs of splitting or cracking. Slight discolouration of the cable shall not be deemed a failure, but the printing, core identification and colour coding shall remain legible. When cooled, the cable shall be freed from the mass, removed from the mandrel and straightened. The specimen shall then be subjected to the test in **7.11.2** and subsequently the insulation shall be removed from the specimen and the conductor examined for pitting.

7.11.2 *Bending Test* — This test is a supplement to the test described in **7.11.1** and shall be carried out at room temperature. One of the the ends of the specimen shall be attached to a horizontal mandrel, and the other loaded in accordance with the values given in the individual cable specification. The mandrel shall be rotated until the total length of the specimen is wound onto it. The mandrel shall then be rotated in the opposite direction until the total length of the specimen is wound onto it, so that the compressed surface in the first case becomes the stretched surface in the second. The cycle shall be carried out twice. On completion of this test, the specimen shall withstand the voltage test described in **7.4.1**.

7.12 Surface Resistance

7.12.1 Two specimens of 0·15 m length shall be taken from two different cross-sections of finished cables. Two electrodes of tinned copper wire or metal ribbons shall be applied at the centre of the specimens as shown in Fig. 1. The distance between the inside edges shall be 25 mm. The electrodes shall provide good electrical contact with the surface of the specimens. Sufficient length of wire shall be allowed to connect the cable entering the chamber shown in Fig. 2.

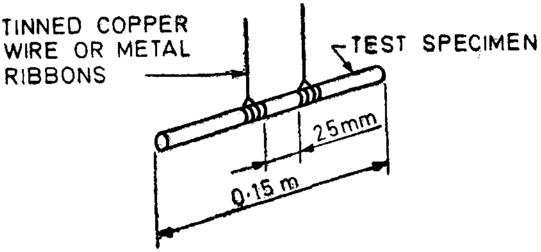
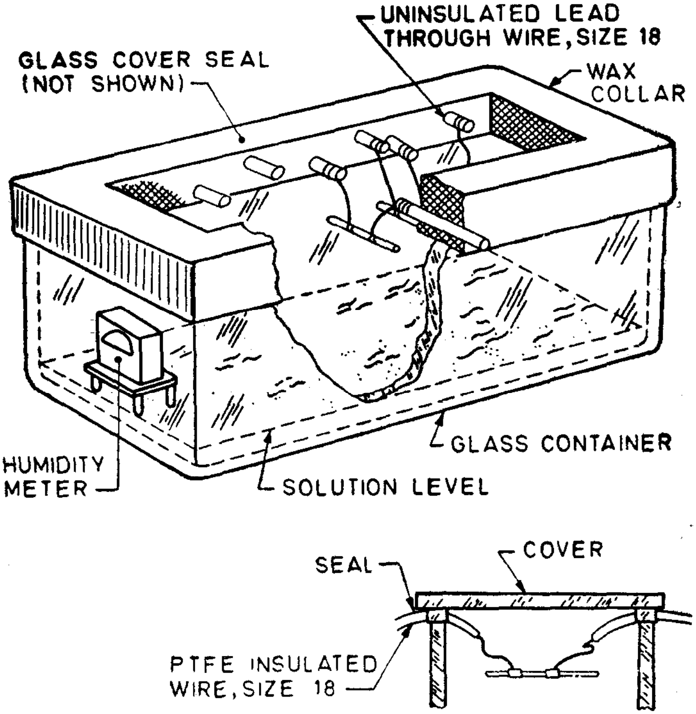


FIG. 1 TEST SPECIMEN

The electrode wires shall be soldered to the cables, so that their ends are at least 25 mm from the inner wall of the chamber. The prepared specimens shall be cleaned to eliminate any contamination. They shall not be touched by hand at any time.


UNINSULATED LEAD THROUGH WIRE, SIZE 18
GLASS COVER SEAL (NOT SHOWN)
WAX COLLAR
HUMIDITY METER
SOLUTION LEVEL
GLASS CONTAINER
SEAL
COVER
PTFE INSULATED WIRE, SIZE 18

ALTERNATIVE ARRANGEMENT

FIG. 2 SURFACE RESISTANCE TEST CHAMBER

The environmental conditions of the chamber shall be as follows and shall be maintained for a period of 96h:

a) Relative humidity : ($95 + 5$ percent),
b) Ambient temperature : 27 ± 2°C, and
c) The insulation resistance measured between opposite output cables shall be at least $10^6 M\Omega$.

7.12.2 At the end of this period, a voltage between 200 and 500 V dc shall be applied to them for 1 m and the resistance between the electrodes measured. The surface resistance shall be calculated by multiplying the value obtained in this manner by the diameter of the specimen in millimetres.

7.12.3 A voltage of 2 500 V rms with a frequency between 40 and 60 Hz shall be applied for 1 min between the electrodes. No arcing, smoke emission, burning marks, or crazing shall occur. After a rest period of 15 to 20 min, the surface resistance shall be measured again. In each of the measurements, the value obtained multiplied by the diameter of the specimen in mm shall be at least 1 250 M Ω/mm.

7.13 Low Temperature Test

7.13.1 One of the ends of a specimen of suitable length shall be attached to a horizontal mandrel and the other and loaded according to the values given in the individual cable specification. The assembly shall be placed in a chamber at a temperature of $-55 \pm 2°C$ and maintained at this value for 1 h.

7.13.2 The mandrel shall be rotated until the total length of the specimen is wound onto it. While still maintaining at this temperature, this mandrel shall be rotated in the opposite direction until the total length of the specimen is wound onto it, so that the compressed surface in the first case becomes the stretched surface in the second. The cycle shall be carried out twice. After return to room temperature, the insulation of the specimen shall exhibit neither crazing nor cracking. On completion of this test, the specimen shall withstand the voltage test described in **7.4.1**.

7.14 Blocking Test

7.14.1 A specimen shall be wound onto a mandrel of diameter given in the individual cable specification in two superimposed layers, each consisting of 6 to 8 closely wound turns. The assembly shall be placed for 6 h in a natural draught oven at the temperature stated in the individual cable specification. After 6 h the assembly shall be removed from the oven and cooled for at least 1 h at 20°C. The specimen shall then be unwound from the mandrel without damage to its surface and the turns shall separate easily from each other. Any delamination of the insulation shall be considered a defect. On completion of this test, the specimen shall withstand the voltage test described in **7.4.1**.

7.15 Climatic Test

7.15.1 The test sequence for the combined humidity, temperature and pressure tests shall be as follows and all tests shall be made at atmospheric pressure. The functioning tests shall consist of a visual examination.

a) *First day* — Start of 24 hours period dry heat at temperature stated in the individual cable specification.

b) *Second day* — Transfer to cold chamber at the temperature stated in the individual cable specification for 8 hours, then transfer to humidity chamber at 40°C and 98 percent relative humidity minimum for 16 hours.

c) *Third day* — Transfer to cold chamber for 8 hours; transfer to humidity chamber for 16 hours.

d) *Fourth day* — Transfer to cold chamber for 8 hours; transfer to humidity chamber for 16 hours.

e) *Fifth day* — Transfer to cold chamber for 8 hours; transfer to humidity chamber for 16 hours.

f) *Sixth day* — Transfer to extra-cold chamber at the temperature stated in the individual cable specification for 6 hours. Remove from extra-cold chamber and leave at room temperature for 1 hour

7.15.2 For the purpose of the humidity, temperature and pressure tests, it shall be permissible to use three separate chambers, as given below:

a) dry heat chamber;
b) low temperature chamber, but without low pressure facilities; and
c) high humidity chamber.

NOTE — Where separate chambers are used, the specimen shall be transferred as quickly as possible from one chamber to the other.

7.15.3 For the humidity, temperature and pressure tests and for the tropical exposure tests, a specimen of the cable shall be wound into a coil on a mandrel, the ends of the specimen being sealed and brought outside the test chamber. For specimens with an overall diameter not exceeding 6 mm, the mandrel diameter shall be six times the specimen diameter and there shall be six turns of cable, but for larger specimens, the mandrel diameter shall be 12 times that of the cable and there shall be two turns of cable. At the conclusion of the tests, the specimen shall be examined and shall not show, to normal vision, any appreciable signs of deterioration and the identification shall remain legible. In addition the specimen shall be subjected to the voltage test (**7.4.1**).

7.15.4 After application of the voltage test, the insulation resistance of the specimen shall be measured at 500 V dc in water at room temperature and shall not be less than that stated in the individual cable specification. For the tests for resistance to fungus growth, a 250 mm specimen shall have one end stripped back to expose a 50 mm length of each of the component parts of the cable. At the conclusion of the test, no mould growth shall be apparent to normal vision and there shall be no appreciable deterioration of the constituent parts of the specimen.

7.16 Installation and Service Durability Tests

7.16.1 The scrape abrasion resistance is defined as the number of complete cycles required for the scraping blade to abrade through the cable insulation and stop the machine. The minimum number of cycles which the specimen must withstand, shall be 100 in each of the four tests. One cycle is defined as the travel of the blade from its central starting point to the end position in both directions and its return to the starting point.

7.16.2 This test shall be carried out at 27±2°C. The scrape abrasion test rig shall conform to the requirements detailed in Fig. 3 and shall consist of a device designed to abrade the surface of the insulation in both directions along the longitudinal axis of the specimens for a distance of not less than 10±1 mm, at a frequency of 55±5 cycles per minute. The test rig shall be provided with a counter to record the number of cycles to failure of the cable insulation and shall be so controlled that when the needle makes contact with the conductor, the machine will stop operating.

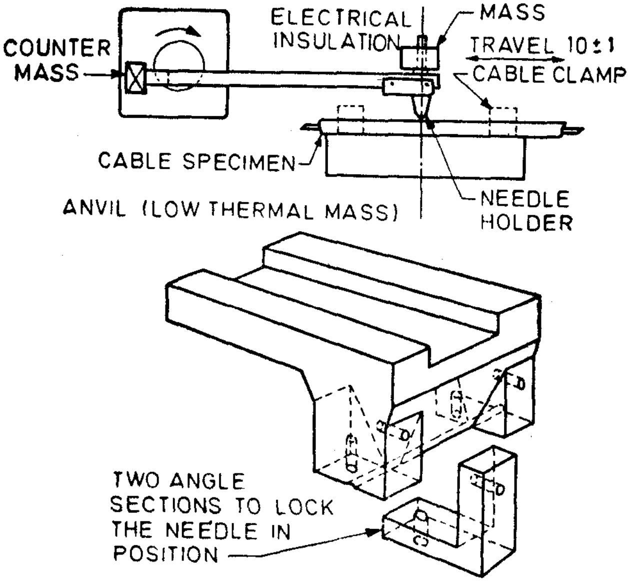
7.16.3 The specimen, which shall be approximately 0·75 m in length shall be firmly clamped to the anvil. The needle shall be loaded with the mass specified in the individual cable specification. Four tests shall be made on each specimen with the specimen being moved forward 100 mm and rotated through 90° in one direction between tests. A new needle shall also be used for each specimen for four tests.

7.17 Identification Durability Test

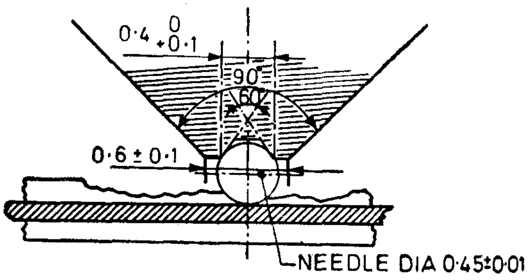
7.17.1 A specimen of cable shall be clamped into the scrape abrasion test rig specified in **7.16.2** with the printed identification uppermost. The length and frequency of the stroke shall be as for the scrape abrasion test. The test shall be monitored throughout and as soon as the underlying layer is exposed or a line is scored through the printing, the machine shall be stopped and the number of cycles recorded. The total mass applied to the abrading member and the minimum number of cycles endured shall be as stated in the individual cable specification. Three specimens shall be chosen from each sample and six tests carried out on each specimen. The test shall be conducted at a temperature of 27±2°C.

7.18 Dynamic Cut-Through Test

7.18.1 The principle of operation of the dynamic cut-through test rig is shown in Fig. 4. The base shall be balanced by adjustment of the counter balance, so that it is motionless with no load applied. The cable specimen, which shall be approximately 0·75 m in length, shall be firmly clamped to the anvil of the test rig so that its axis is at right angles to the cutting edge. The specimen shall be heated to the temperature stated in the individual cable specification, for example, by enclosing the cable sample and cut-through device within an oven fitted with suitable temperature control and monitoring equipment. The beam may project through the wall of the oven and shall move freely.



DETAIL 1: ARRANGEMENT FOR NEEDLE HOLDER

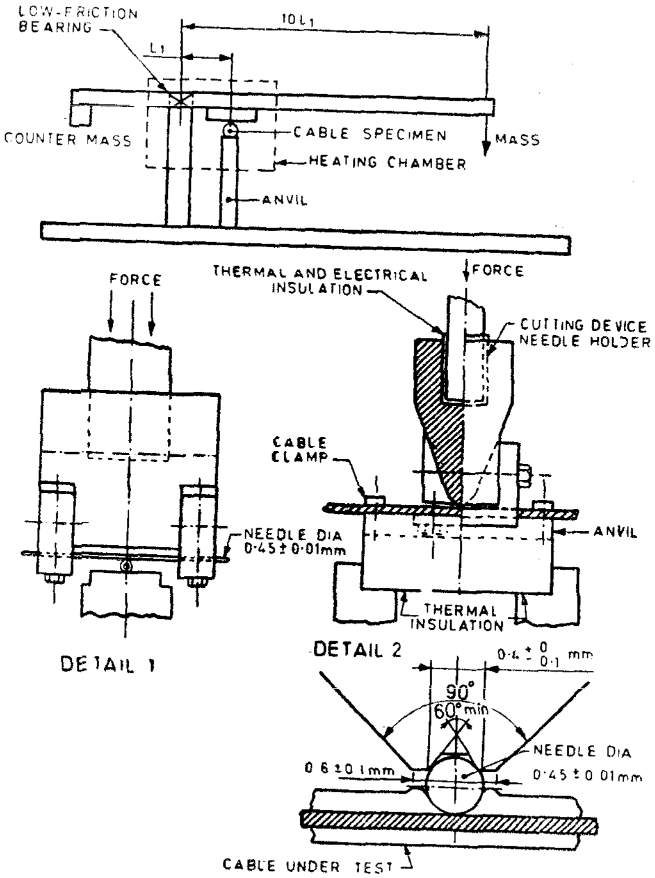


DETAIL 2 : PROFILE END (SECTION OF NEEDLE HOLDER)

All dimensions in millimetres.

FIG. 3 GENERAL ARRANGEMENTS FOR SCRAPE ABRASION TEST

7.18.2 By means of any convenient method, mass shall be added at the end of the beam so that load is applied to the specimen at a constant rate of 50 ± 10N/min until cut-through to the conductor is achieved. The test shall be made four times for each specimen and between tests the specimen shall be moved forward 75 mm and rotated through approximately 90° in one direction. The mass required at the specimen to achieve cut-through to the conductor shall not be less than that stated in the individual cable specification.



Detail 1 — Proposed mounting.
Detail 2 — Suggested design for the sectional extremities of the needle holder.

NOTE — The temperatures of the cutting device, the cable and the anvil shall be stabilized before measurement.

FIG. 4 GENERAL REQUIREMENTS OF THE APPARATUS FOR MEASURING RESISTANCE TO CUT-THROUGH

7.19 Resistance to Notch Propagation

7.19.1 By means of a razor blade placed in the mounting (*see* Fig. 5), a notch shall be made in the specimen perpendicular to the cable axis and of a depth as stated in the individual cable specification. The specimen notched in this manner shall be wound onto a mandrel of diameter equal to 6 times that of the specimen. The notch shall not propagate to the conductor. While still on the mandrel, the sample shall be immersed in water at 20°C, and a voltage of 1 kV rms applied between the conductor and the water for a period of 1 min. The water shall contain 3 percent sodium chloride and 0·2 percent wetting agent.

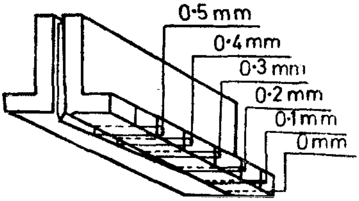


Fig. 5 Blade Mounting

7.20 Deformation Test (Cable Sizes 0·15 to 3 mm² only)

7.20.1 The apparatus shown in Fig. 4 shall be adapted as shown by replacing the needle with a mandrel having a diameter equal to the nominal diameter of the specimen to be tested, and mounting a dial gauge to measure movement of the end of the beam due to deformation of the specimen. The test procedure shall be as that described in **7.18**. The specimen shall be submitted to the load for the time and at the temperature required in the individual cable specification.

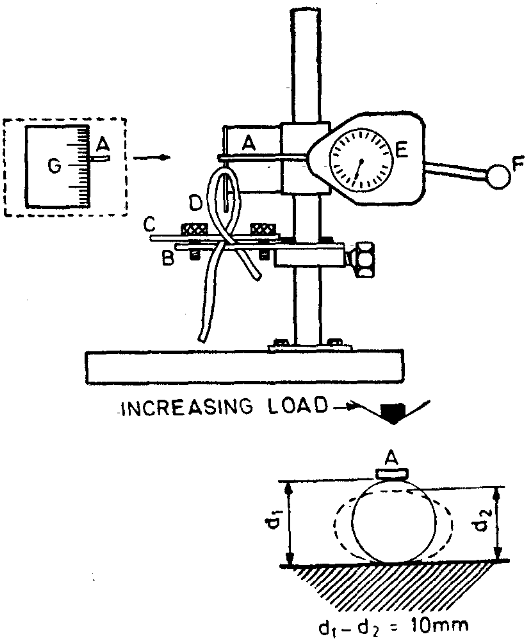
7.20.2 The deformation of the specimen shall be expressed as a percentage of the normal diameter of the cable. The movement measured by the dial gauge shall be multiplied by 100 and divided by the nominal cable diameter to give the percentage deformation. The percentage deformation shall not exceed that required in the individual cable specification.

7.21 Pliability Test

7.21.1 A specimen, approximately 180 mm in length, shall be made into a loop of 50 mm diameter and placed in the apparatus as shown in Fig. 6. Load shall be applied to the specimen by depressing the dynamometer operating handle and the specimen depressed by 10 mm. The load applied by the dynamometer shall be noted. Five tests shall be carried out, one on each of five specimens, and the mean value calculated.

Note 1 — The maximum load shall not exceed that required by the individual cable specification.

Note 2 — This test is applicable only to cable sizes 5 mm² and smaller.



A = loading arm
B = specimen platform
C = clamp plate
D = specimen
E = load indicator
F = operating handle for dynamometer
G = deflection indicator scale

FIG. 6 PLIABILITY TEST APPARATUS

7.22 Construction

7.22.1 All cables shall be checked to ensure compliance with the requirements of the individual cable specification and this standard relating to construction and dimensions. All completed cables shall be examined along the entire length for defective workmanship.

7.23 Non-inflammability Test

7.23.1 This test shall be carried out on at least three specimens of each type, immediately after conditioning for 24 h at 27 ± 2°C and at 65 ± 5 percent relative humidity. A specimen of suitable length shall be inclined at an angle of 60° to the horizontal in a chamber approximately 0·60 m high, 0·30 m wide and 0·30 m deep. The chamber shall be open at the top and front with adequate air circulation for complete combustion but without draught.

7.23.2 The specimen shall be about 0·15 m from the front of the chamber and parallel to it; its lower end shall be attached by a clamp and its upper end shall pass over a pulley and shall be loaded with sufficient mass to keep the specimen taut throughout the test. The length of specimen portion between clamp and pulley shall be 0·60 m, and shall be marked 0·20 m from the bottom end to indicate flame application point. A flame produced by a suitable burner shall be applied for 30s. The burner shall have an aperture of 9·5 to 10 mm and shall be adjusted to provide a flame of 75 mm with a cone of one third of the flame length. The burner shall be mounted perpendicular to the specimen centre line at 30° to the vertical plane in which the specimen is positioned. The temperature of the hottest part of the flame measured with a pyrometer shall be at least 950°C. The burner shall be so arranged that this hottest section is located on the mark previously made on the specimen. A tissue paper shall be held horizontally below the specimen.

7.23.3 *For Approval After Removal of the Burner*

a) The burnt length shall not exceed 75 mm in either direction from the flame application point;

b) The flame extinction time shall not exceed 30 seconds; and

c) Ignited particles detached from the specimen shall not ignite the tissue paper.

7.24 Fire Resistance Test

7.24.0 *General* — These requirements shall apply only to cables to be installed in designated fire zones. They do not relate to the non-inflammability requirements.

NOTE — In this particular instance, a fire resistant cable is one capable of withstanding, for a period of at least 5 minutes the application of heat by a standard flame without any malfunction that would jeopardize the safety of the aircraft, or failure that would aggravate an existing hazard.

7.24.1 *Standard Flame* — The standard flame shall be produced by burning a mixture of propane gas and air to give a uniform and consistent flame having the following characteristics:

a) A flame intensity of 530 ± 20kW/m².

b) A cross-section of not less than 0·004 4 m².

c) A temperature of 1 100 ± 50°C.

NOTE — Flame characteristics in **7.24.1** shall be established by the use of suitable calibration equipment as given below:

Example 1 — *Flame temperature*: Measurement of the flame temperature shall be by means of an appropriate thermocouple located in the flame at a point to be subsequently occupied by the mid point of the test specimen and approximately 25 mm above the burner top plate.

Example 2 — *Flame intensity*: The flame intensity (kW/m^2) shall be measured initially by the use of an appropriate flame calorimeter. Before the start of each test, the maintenance of this characteristic shall be checked. This may be carried out by the use of the flame calorimeter or by the use of a more simple transfer standard, such as the time to melt a standard metallic wire.

7.24.2 *Type and Arrangement of Specimen*

7.24.2.1 The length of the specimen shall be not less than 0·6 m. The specimen shall be mounted on a test rig, straight and horizontally, as shown in Fig. 7. Electrodes consisting of narrow metal tapes applied helically and used to check the electrical integrity in the flame area shall have a thermal capacity which is small compared with that of the specimen. Any mechanical supports shall not be less than 1·5 times the flame diameter from the centre of the test flame. The specimen shall be mounted in the flame, so that the centre of the specimen is over the centre of the burner and at a height corresponding to the point at which the flame conditions in **7.24.1** are measured.

7.24.3 *Environmental Conditions* — The test for contamination by fluids shall be carried out in still air. Samples shall be tested after immersion for not less than 24 h, one sample in each of the following aircraft fluids at 27°C. Each sample shall be subjected to the fire test 1 h after removal from the fluid:

a) Aviation fuel;
b) Lubricating oil;
c) Hydraulic fluid;
d) De-icing fluid; and
e) Fire extinguisher fluid.

7.24.4 *Vibration* — The specimen in the flame area shall be vibrated in a single plane at a frequency in the range 30 to 60 Hz and with an amplitude in the range ±0·4 to ±0·75 mm.

7.24.5 *Electrical* — For the duration of the test, the specimen shall have a potential of 125 V rms applied between the conductor and the metal tapes and shall carry a current as shown in Table 3.

TABLE 3 CURRENT TO BE CARRIED BY THE CABLE DURING THE FIRE RESISTANCE TEST

(*Clause* 7.24.5)

NOMINAL CABLE CROSS-SECTION (1) mm²	APPROXIMATE NUMBER (2)	CURRENT (3) *A*
0·4	22	9
0·6	20	12
1·0	18	16
1·2	16	20
2·0	14	24

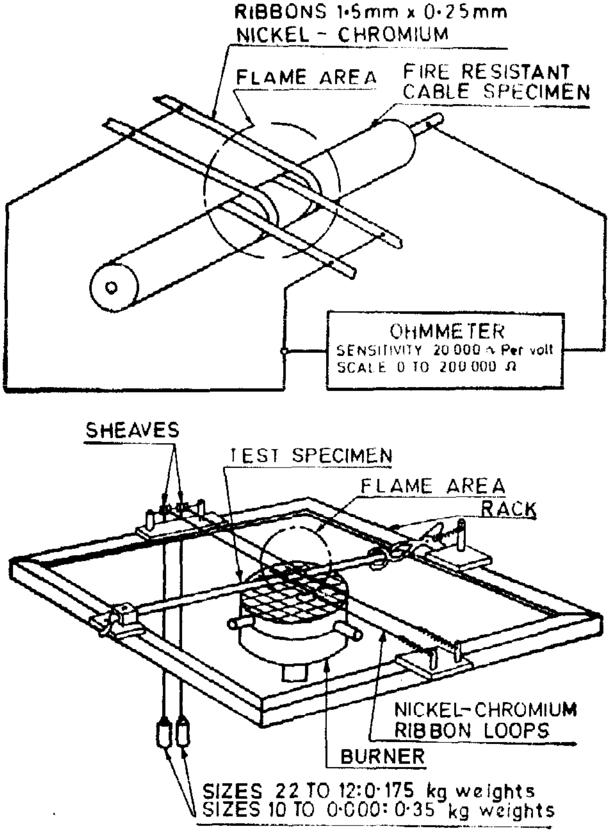


FIG. 7 EQUIPMENT FOR FIRE RESISTANCE TEST

7.24.5.1 *Test criteria* — Provision shall be made to check the electrical continuity of the conductor during and after the test. Provision shall also be made to establish during the test that the insulation leakage current is such that the total current drawn from the source (leakage plus load current) does not exceed that required to operate the appropriate circuit protection. This can be achieved, for example, by measuring the insulation resistance of that part of the specimen in the flame during the test, the criteria being that the minimum value of insulation resistance shall be 10 000 Ω measured at a voltage of 125 V or, alternatively, that the minimum leakage current shall not exceed 12·5 mA/cm at 125 V.

7.25 Overload Resistance Test

7.25.0 *General* — This test is intended to verify that no smoke is emitted at a current overload level sufficient to raise the conductor temperature to T_1 and that, with an overload raising the conductor temperature to T_2, the insulation is neither ignited nor destroyed. The test shall be carried out on two specimens with a cross-section of 0·6 mm².

7.25.1 *Assembly* — Each specimen, 0·75 to 1 m in free length, shall be installed horizontally in still air in front of a screen and lightly loaded at its ends to avoid any sagging during the test. The current applied to heat the specimen shall be held at the value given in the individual cable specification for the time specified. The test shall be carried out at 27 ± 2°C in a chamber where the assembly is protected from any draught. Air extraction shall be provided, but shall be applied only at the end of the test. To identify the appearance of smoke a screen with black and white horizontal stripes or any other device may be used.

7.25.2 *Temperature Evaluation* — This should be determined by measurement of the variation of voltage drop in the central section of the specimen (two-thirds of the free length at most), marked by the voltage pick-off points.

$$\frac{\Delta UT_1}{\Delta UT_0} = \frac{RT_1}{RT_0} = 1 + \alpha\ (T_1 - T_0)$$

where

α = temperature coefficient of resistance of the conductor material at 20°C;

T_1 = final temperature; and

T_0 = ambient temperature.

7.25.3 *Approval*

7.25.3.1 The current shall first be applied for 15 min at a first value I_1, raising conductor temperature to T_1, there shall be no:

a) appreciable smoke emission;

b) smell, or

c) significant colour change.

7.25.3.2 The current shall then be applied for 15 min at the second value I_2, raising the conductor temperature to T_2, there shall be no:

a) spontaneous combustion,

b) splitting of the insulation, or

c) baring of the conductor.

7.26 Heat Cycling — A specimen, 10 m in length, shall be coiled in a flat spiral on a heat-proof former, the internal diameter of the coil being not less than 100 mm. The assembly shall then be stored in an air oven at the temperature and for the time required by the individual cable specification, removed and allowed to cool to room temperature for at least 2 h. This cycle shall be carried out four times. Before the first cycle and after the fourth cycle, the conductor shall be examined radiographically. If there is any significant change in the conductor shape, the specimen shall be deemed not to comply with the individual cable specification, or this standard. A slight waviness over a length of approximately 100 mm of the conductor shall not, however, be regarded as a tendency to kink.

7.27 Delamination and Retraction — A specimen 0·3 m in length shall be cut at the ends so that the conductor is flush with the insulation. The specimen shall be placed in an air circulating oven for a time and at a temperature as specified in the individual cable specification. The specimen shall then be removed from the oven, returned to ambient temperature, and examined for any tendency of the insulation to retract. Any such retraction shall not exceed the value stated in the individual cable specification. The specimen shall be examined visually to detect any delamination of the insulation. Any delamination of the layers either along or at the ends of the insulation shall be considered a defect.

7.28 Mechanical Strength of Wires from Copper or Copper Alloy Conductors

7.28.1 The tensile strength and minimum elongation of copper and copper alloy wires removed from the finished cable shall be measured by means of an instrument giving an immediate and accurate indication of the load applied. The accuracy of the instrument shall be within 1 percent. The values measured shall conform to the values given in the individual cable specification. For these tests, the gauge length on the test specimen shall be 250 mm and the clamps shall be separated at a rate not exceeding 100 mm/min. The tensile strength of plated copper wire shall be calculated on the original cross-sectional area of the wire. The specimen wires shall be taken at random from the cross-sectional area of the wire. The specimen wires shall be taken at random from the conductor. The tensile strength and elongation at break of the copper alloy conductors, that is sizes 0·25 mm^2 and smaller, shall be measured on the complete conductor.

7.29 Mechanical Strength of Wires from Aluminium or Aluminium Alloy Conductors

7.29.1 The tensile strength of aluminium alloy conductors shall conform to the values given in the individual cable specification. For this test, not less than 10 wires shall be taken from size 9 to 34 mm² conductors, and not less than 20 wires from size 42 mm² and larger. The sample wires shall be taken at random from the conductor. The test conditions shall be identical with those prevailing for the test described in **7.28**.

7.29.2 In addition, the wires shall not break when they are wound around a mandrel of their own diameter to form a close helix of at least eight turns, unwrapped six turns and again closely re-wrapped in the same direction as that of the first wrapping.

7.30 Visual Inspection of Wires — The coated copper wires and aluminium wires used for the conductors and metal braids shall be visually inspected to ensure that they are clean, bright and free from surface irregularities.

7.31 Tin Plating of Wires — The tinning of the wires shall be tested for compliance with the requirements of the individual cable specification.

7.32 Nickel Plating of Wires

7.32.1 The copper for the conductors shall be shown by any convenient method to be coated with nickel to a radial thickness not less than 1·27 μm.

7.32.2 Samples of the wires in the ' as received ' state and after stretching to elongate a given length of copper wire by 10 percent or copper alloy wire by 5 percent, shall be subjected to a persulphate test such that the period of immersion in the test solution shall be 30 min. The mass of copper dissolved shall not exceed:

a) 1 g/m² for wire ' as received ' and

b) 2·5 g/m² for wire after stretching.

7.33 Silver Plating of Wires

7.33.1 The copper or copper alloy wire used for the conductors and metal braids shall be shown by any convenient method to be coated with silver to a radial thickness at any point not less than that equivalent to the appropriate minimum mass in milligrams per metre specified in the individual cable specification.

7.33.2 The continuity and adherence of silver plating shall be determined as follows.

7.33.2.1 *Continuity* — Three wires of a length not less than 0·15 m shall be taken from a conductor previously straightened by hand. The specimens shall be degreased without damaging the conductor and then wiped, using a clean dry cloth. The wires cleaned in this manner shall at no time be touched by hand. The specimens shall be immersed for 30 s in a solution of sodium polysulphide (ρ1·142 g/ml) at 27°C and then washed carefully in water. The specimens shall then be immersed for 15 s in a hydrochloride acid solution (ρ1·088 g/ml) at 20°C, and then washed carefully in distilled water. When the specimens are examined with the unaided eye, no adherent or distinctly visible black spots shall be observed. Any blackening occurring less than 15 mm from each end shall be disregarded.

7.33.2.2 *Adherence* — Three wires from each specimen, not less than 0·15 m in length, shall be taken from a conductor previously straightened by hand. One wire of the conductor shall be wound around a mandrel of the same diameter as that of the wire so as to form three adjacent coils. The metal coating shall be examined with the unaided eye; it shall not show any detachment.

APPENDIX A

(*Clause* 4.4)

FORMULAE FOR CALCULATING BRAIDING DETAILS

A-1. FORMULAE FOR GLASS BRAID

A-1.1 Filling Factor — The filling factor K_f is defined as:

$$\frac{m\,n\,d_w}{2\,\pi\,D}\left[1+\frac{\pi^2 D^2}{L^2}\right]^{0\cdot 5}$$

A-1.2 Lay Factor — The lay factor K_L is defined as:

$$1+\frac{\pi^2 D^2}{L^2}$$

where

D = mean diameter of the braid (that is, diameter under braid + 2 d_r);

d_w = effective width of one end;

d_r = effective radial depth of one end;

L = lay length;

m = total number of spindles; and

n = total number of ends per spindle.

Values of d_w and d_r for the sizes of yarn in common use are stated in the individual cable specification.

A-2. FORMULAE FOR METAL BRAID

A-2.1 Filling Factor — The filling factor K_f is defined as:

$$\frac{m\,n\,d_w}{2\,\pi\,D}\left[1+\frac{\pi^2\,D^2}{L^2}\right]^{0\cdot5}$$

A-2.2 Lay Factor — The lay factor K_L is defined as:

$$1+\frac{\pi^2\,D^2}{L^2}$$

where

D = mean diameter of the braid;

d_w = diameter of the braiding wire;

L = lay of the braiding wire;

m = total number of spindles; and

n = total number of ends per spindle.

APPENDIX B

(*Clause* 5.3.7)

MANUFACTURERS IDENTIFICATION MARKS

B-1. CABLE IDENTIFICATION

B-1.1 Because of variation in requirements for cable coverings, the minimum size of cable that can be marked will depend upon the overall diameter to be stated in the individual cable specification.

B-1.2 The marking shall consist of a legend printed in a contrasting colour to that of the covering, repeated at 150 to 500 mm, and containing the following information.

a) Name of cable (wire) or number of specification, type and size;
b) Country of origin (3 letter code);
c) Manufacturer within country of origin (2 letter code);
d) Year of manufacture (1 letter code); and
e) Cable size or area of cross-section.

B-1.3 Dashes shall be used to separate name or specification, type, size and the letter code detailed in **B-1.2**, thus for example:

(Specification) – (Type) – (Size) – IND, AA W - (Area)*

APPENDIX C

(*Clause* 7.3.1)

CURRENT RATING TESTS

C-1. GENERAL

C-1.1 Current ratings shall be established for cables manufactured in accordance with the individual cable specification and complying with this standard using as a basis the normal ambient working temperature allowed in the individual cable specification. Current ratings shall cover the long term (continuous) case and the shortest term practicable and shall be presented for each size of cable in the form of a stepped current versus time curve to log-log scales. For times greater than 1 min, the criterion shall be temperature rise in the conductor. For times of less than 1 min, the criterion shall be whether or not there is damage to the cable.

C-1.2 Before the commencement of the tests, the conductor resistance shall be measured at 20°C. When the current ratings have been established, the values measured shall be corrected for maximum specified conductor resistance at 20°C by multiplying by $\sqrt{R/R_{\max}}$, where R is the measured value and $R_{\max}$, the specified maximum conductor resistance at 20°C.

C-1.3 Current ratings shall be determined by testing for the largest and the smallest of the sizes in the individual cable specification, and for alternate intermediate sizes. Ratings for sizes not tested, provided the conductor material is the same, may be obtained by interpolation.

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*Alternative.

C-1.4 A formula shall be developed, and shall be shown in the current rating charts in the individual cable specification, to modify the long term ratings when cables are used in an ambient temperature different from that upon which the tests were based.

C-1.5 This formula normally provides a downgrading factor where the cable is used in an ambient temperature within less than 40°C of its maximum conductor working temperature. It should be used with caution as an upgrading factor where the ambient temperature is more than 40°C below the maximum conductor temperature, and should not normally be used where the reference between the two temperatures is greater than 60°C.

C-2. LONG TERM RATINGS

C-2.1 Long term current ratings shall be those at which, for the cable construction specified and for the temperature rise allowed above the stated ambient temperature, the maximum stabilised conductor temperature permitted by the individual cable specification is not exceeded. Long term current ratings shall be declared for the following periods:

a) Continuous,
b) 5 min ±5 s,
c) 1 min ±2 s.

and for each of the following conditions:

a) Single cable in free air, and
b) Three bunched cables of the same size and carrying the same current in free air.

NOTE — Large bunches are not considered because of the diversity factor that then begins to operate, as, at any one time, some cables will be unloaded or only lightly loaded and will act as a heat sink.

C-3. SHORT TERM RATINGS

C-3.1 Short term current ratings shall be those for which the maximum temperature reached by the conductor is just below that at which there is evidence of damage to the cable, as defined in the individual cable specification. Unless specified otherwise in the individual cable specification, short term current ratings shall be determined and declared for single cables in free air only for the following periods:

a) 0·35±0·025 s,
b) 2·0 ±0·2 s,
c) 10·0±0·5 s, and
d) 60·0±2·0 s.

C-4. APPARATUS, MEASUREMENT AND RECORDING

C-4.1 The following comprises the basic apparatus for long term and short term current rating measurements.

C-4.1.1 An oven, of large volume relative to the cable specimens, and capable of being set to any temperature between 20°C and the maximum declared for the individual cable with means, where necessary, of circulating the air inside the oven and of venting fumes safely to the outer atmosphere. The air surrounding the cable shall be static during the application of the current.

C-4.1.2 An essentially constant current dc from a 50 to 60 Hz ac or power supply (capable of loading the largest cables for the shortest times necessary) together with a switching mechanism capable of switching the energizing currents with the least delay.

C-4.1.3 Accurate means of monitoring the oven temperature and the conductor temperature of the cable specimens.

C-4.1.4 Suitable measuring and recording equipment to monitor voltage and current accurately, together with a time base accurate to ± 10 ms.

An example of a suitable apparatus is shown diagrammatically in Fig. 8.

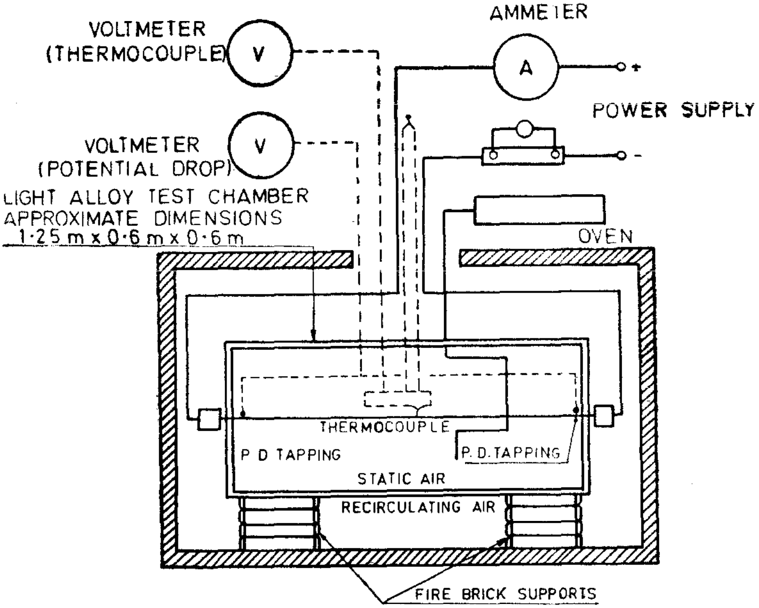

Fig. 8 Current Rating Test Oven and Associated Equipment

C-4.2 Cable samples shall be of such a length that a temperature gradient is not present at the ends and, in any case, more than 1 metre long and shall be supported horizontally in the oven without subjecting them to tension.

For the purpose of long term rating of three bunched cables, the bunch of cables shall be tied with a suitable lacing cord at intervals of approximately 75 mm.

C-4.3 Oven temperature shall be monitored visually by an indicating instrument. Voltage shall be measured at the pick off points indicated in Fig. 8. Current and voltage drop shall be measured throughout the test and recorded against a time base. Conductor temperature shall be measured by means of a thermocouple placed under the cable insulation and against the conductor. The response time of the thermocouple shall be less than 200 ms and the heat sink effect of couple and leads, for example, for small gauge cables, shall be at a minimum. The diameter of the thermocouple wire shall be approximately 0·15 mm. The conductor temperature shall be recorded on the same time base as voltage and current. Alternatively, the conductor temperature may be derived from the change of resistance calculated from the voltage drop across the specimen. The latter method is usually more accurate for smaller sizes of cable, while for a thermocouple measurement is usually more accurate on gauge 12 cables and larger. The monitoring equipment shall be calibrated as frequently as necessary to maintain confidence in its accuracy.

C-5. PROCEDURE FOR LONG TERM RATING TESTS

C-5.1 Because these tests are non-destructive, the same cable sample(s) may be used for successive time ratings for a given size of a particular cable.

C-6. PROCEDURE FOR SHORT TERM RATING TESTS

C-6.1 Separate groups of specimens are needed for different time ratings and additionally for any one time rating of each size of cable.

C-6.2 The test current shall be passed nine times through each specimen with sufficient time in between to allow the specimen to cool to ambient temperature.

C-6.3 The approximate test current necessary to cause the onset of damage after nine applications of the test current shall be determined empirically for the given size of cable for the given specified time period. Further tests, each of nine applications of the test current, shall then be made on separate specimens of the same size of cable, with a suitable spread of current. If no damage occurs during the confirmatory test, this current shall be the declared rating, for the specified time period, for that particular size and type of cable. If damage occurs, during the confirmatory test, further tests shall be made, at reduced currents, until the foregoing condition is met.

The maximum current that causes no damage to the cable after nine applications of the test current shall be the declared rating, for that time period of that size of that particular cable.

A similar procedure shall be used to determine the ratings for the other specified times for that size of the particular cable, and similarly again for the other sizes of the cable.

C-7. ANALYSIS OF DAMAGE TO CABLE SPECIMENS

C-7.1 After sustaining nine applications of the test current, each cable specimen shall be checked visually for damage and the manufacturer shall produce evidence that the given size of the cable will, after nine applications of the test current at the declared rating, still satisfy the requirements of **7.11** of this standard in relation to the requirements of the individual cable specification.

INDIAN STANDARDS ON AIRCRAFT ELECTRICAL EQUIPMENT

IS:

2032 (Part XV)-1976	Graphical symbols used in electrotechnology: Part XV Aircraft electrical symbols
7854-1975	Voltages and frequency for aircraft electrical systems
7855-1975	Form of declaration of performance of aircraft electrical equipment
7856-1975	Safety features for ground power units for direct current aircraft servicing and engine starting
7857-1975	Aircraft-fuel nozzle grounding plugs and sockets
7915-1976	Dimensions for connections for aircraft ground electrical supplies
8252 (Part XVIII)-1978	Environmental tests for aircraft equipment: Part XVIII Magnetic influence
8705-1978	Static invertors for aircrafts
8706-1978	Safety features for alternating current ground power units for aircraft servicing
8834-1978	Dimensions for general purpose push-pull three-pole circuit breakers for aircraft
8852-1978	Dimensions for general purpose push-pull single-pole circuit-breakers for aircraft
8946-1978	General requirements for rotating electrical machinery for aircraft
8980-1978	General purpose push-pull single-pole circuit-breakers for aircraft
8981-1978	Extra low voltage and low voltage spring return non-latch switches for aircraft
9156-1979	DC generators for aircraft
9174-1979	Dimensions for single hole mounted lever operated switches for aircraft
9196-1979	Rotary and linear actuators (ac and dc) for aircraft